

WHAT IS CLAIMED IS:

1. A multiwell plate assembly comprising:
 - a first tray comprising an array of sample wells, wherein each sample well comprises an electrode having an electrical connection that passes through an opening in a wall of said sample well;
 - a second tray comprising a plurality of cell layers such that said second tray can be coupled to said first tray to form a plurality of assay chambers such that each assay chamber comprises:
 - a first compartment;
 - a second compartment; and
 - at least one intact or permeabilized cell layer separating said first compartment from said second compartment.
2. The multiwell plate assembly of Claim 1, wherein the first compartment and second compartment of each assay chamber each comprise at least one electrode.
3. The multiwell plate assembly of Claim 1, wherein said cell layers are in a substantially horizontal orientation on a bottom surface of said second compartments.
4. The multiwell plate assembly of Claim 1, wherein said first compartment contains a different ion concentration from said second compartment.
5. The multiwell plate assembly of Claim 1, wherein said first compartment and said second compartment contain substantially equal ion concentrations.
6. The multiwell plate assembly of Claim 1, wherein said compartment contain one or more ions selected from the group of sodium, potassium, calcium, bicarbonate, phosphate, and chloride.
7. The multiwell plate assembly of Claim 6; wherein at least one of said compartments contains chloride ions.
8. The multiwell plate assembly of Claim 1, wherein said layer of cells is formed with substantially ion impermeable intercell junctions.
9. The multiwell plate assembly of Claim 1, wherein said layer of cells comprises epithelial cells.

10. The multiwell plate assembly of Claim 1, wherein said layer of cells is disposed on a microporous membrane.

11. The multiwell plate assembly of Claim 1, further comprising a voltage clamp.

12. The multiwell plate assembly of Claim 1, further comprising a current clamp.

13. The multiwell plate assembly of Claim 1, wherein said first tray and said second tray are 24-well multiwell plates.

14. The multiwell plate assembly of Claim 1, wherein said first tray and said second tray are 96-well multiwell plates.

15. A method of forming a multiwell plate assembly comprising:

providing a first tray comprising a plurality of sample wells, each sample well of said plurality of sample wells containing one or more electrodes; and

substantially simultaneously placing a plurality of cell layers into said plurality of sample wells.

16. The method of Claim 15, wherein said plurality of cell layers are attached to a second tray.

17. The method of claim 16, wherein said substantially simultaneously placing a plurality of cell layers into said plurality of sample wells forms a plurality of assay chambers such that each assay chamber comprises:

a first compartment;

a second compartment; and

at least one cell layer separating said first compartment from said second compartment.

18. A method of characterizing the biological activity of a candidate compound comprising:

placing a first tray of a plurality of wells having cell layers affixed to said wells into a second tray of a plurality of wells with electrodes mounted therein such that said trays form respective pairs of compartments separated by said cell layers;

placing electrodes in said plurality of wells of said first tray;

exposing one or more cells of said layer of cells to said candidate compound;

and

monitoring an electrical property with said electrodes wherein said property is indicative of a biological activity of said compound.

19. The method of Claim 18, wherein said property is electrical current.
20. The method of Claim 18, wherein said property is electrical potential.
21. An assay apparatus comprising a multiwell plate having a plurality of wells, each well having a top opening and a bottom panel, wherein at least some of said wells have one or more other openings in said bottom panel.
22. The assay apparatus of Claim 21, additionally comprising one or more electrodes extending up through one or more of said bottom opening in at least some of said plurality of wells.
23. The assay apparatus of Claim 22, additionally comprising a printed circuit board from which said one or more electrodes extend.
24. The assay apparatus of Claim 22, additionally comprising a seal between said electrodes and said bottom opening.
25. The assay apparatus of Claim 21, additionally comprising terminal blocks extending up through at least some of said bottom openings.
26. The assay apparatus of Claim 25, wherein said terminal blocks house one or more electrodes.
27. The assay apparatus of Claim 26, wherein said electrodes are immersed in a gel comprising agar, a salt, and water.
28. An assay apparatus comprising:
 - a first multiwell plate having a plurality of wells, each well having a top opening and a bottom panel;
 - a second multiwell plate having a plurality of wells that are aligned with the plurality of wells of said first multiwell plate and are dimensioned such that the plurality of wells on said second multiwell plate fit into the top openings of the plurality of wells of said first multiwell plate to create dual-compartment wells;
 - a first set of electrodes extending into the plurality of wells of said first multiwell plate; and

a second set of electrodes extending into the plurality of wells of said second multiwell plate.

29. The assay apparatus of Claim 28, wherein said first set of electrodes extend through said bottom panels of said plurality of wells of said first multiwell plate.

30. The assay apparatus of Claim 29, wherein said second set of electrodes extend through said top openings of said plurality of wells of said second multiwell plate.

31. The apparatus of Claim 28, wherein each well of said second multi-well plate comprises a top opening and a bottom panel, wherein said second multi-well plate comprises a plurality of through-holes adjacent to the mouths of at least some of said top openings.

32. The apparatus of Claim 28, wherein the wells of said second multi-well plate are sloped.

33. A multiwell assay apparatus comprising:

a pair of adjacent multiwell plates positioned relative to each other to form a plurality of dual-compartment wells;

a pair of printed circuit boards sandwiching said pair of adjacent multiwell plates; and

electrodes extending from each of said printed circuit boards and into at least some of said dual-compartment wells.

34. The assay apparatus of Claim 33, wherein said dual-compartment wells are formed as an array of first compartments and a respective corresponding array of mating second compartments.

35. The assay apparatus of Claim 33, wherein said electrodes extend in substantially opposite directions.

36. The assay apparatus of Claim 33, additionally comprising digitally controlled amplifier electronics coupled to said electrodes for applying and receiving electrical signals to and from said electrodes.

37. A multi-channel voltage clamp for a plurality of dual-compartment assays, said multi-channel voltage clamp comprising:

a plurality of voltage sensors coupled to corresponding ones of said plurality of dual-compartment assays, each voltage sensor having an output dependent on a

voltage difference between the different compartments of the dual-compartment assays to which each voltage sensor is coupled;

a digitally programmable controller receiving as inputs a plurality of signals, each of said signals dependent on a corresponding voltage sensor, said programmable controller also providing a plurality of outputs; and

a plurality of servo amplifiers, each servo amplifier receiving a first signal dependent on the output of a corresponding voltage sensor and a second signal dependent on one of said programmable controller outputs; wherein each servo amplifier is configured to produce an output dependent on changes in said voltage difference between the different compartments of a corresponding dual-compartment assay.

38. The voltage clamp of Claim 36, wherein each of said plurality of outputs of said digitally programmable controller is substantially equal to an inverted one of said input signals to said digital programmable controller.

39. An assay apparatus comprising:

a regular array of dual-compartment assays;

a corresponding regular array of electrodes extending into both compartments of said dual-compartment assays; and

multi-channel digitally programmable electronic control and sensing circuitry configured to substantially simultaneously apply signals to at least some of said electrodes and sense signals from at least some of said electrodes.